

# High-Performance Flow Battery with Inexpensive Inorganic Reactants

**Mike Perry & James Saraidaridis, UTRC**

**Team Members: MIT, Pennsylvania State University, LBNL**

## Project Vision

*A new flow battery system that uses simple, inexpensive reactants and innovative electrolyte balance methods to deliver long duration electricity storage.*



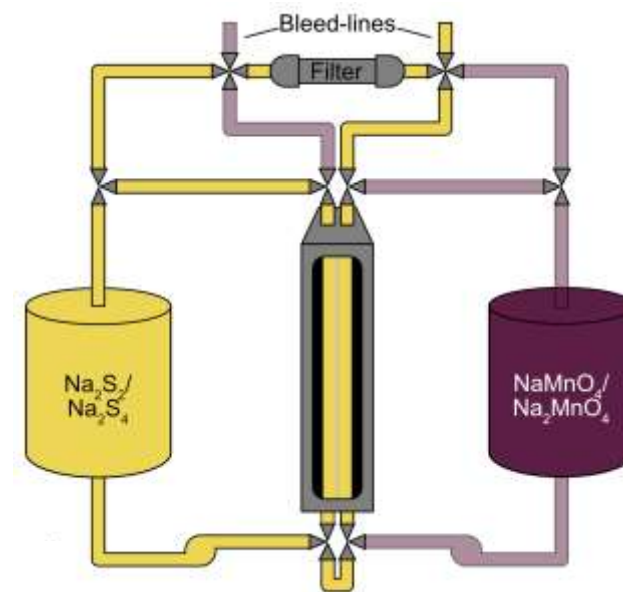
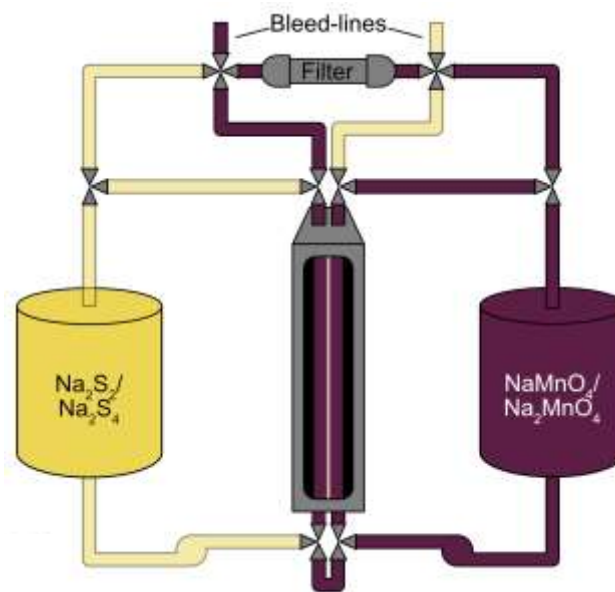
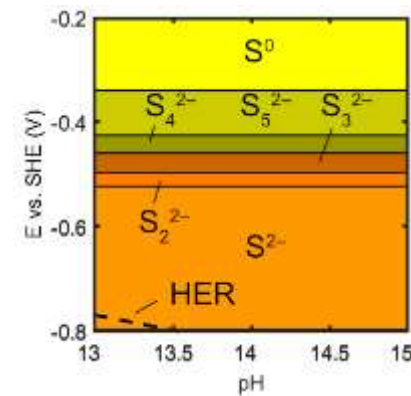
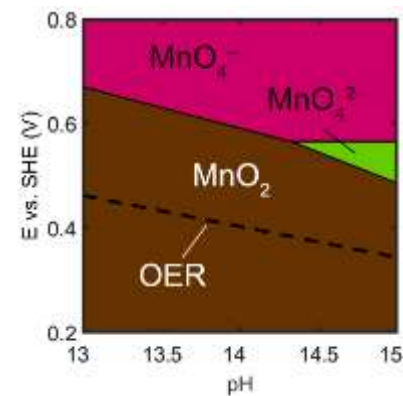
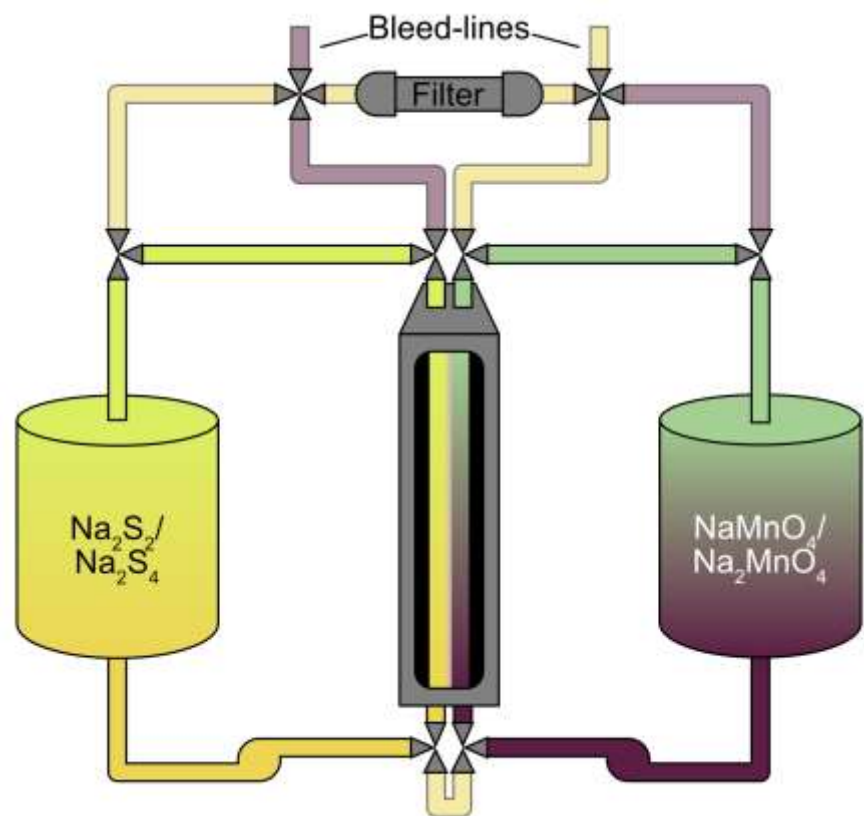
**United Technologies  
Research Center**

Approved for Public Release

Total project cost:	\$3.87M
Length	33 mo.

# The Concept

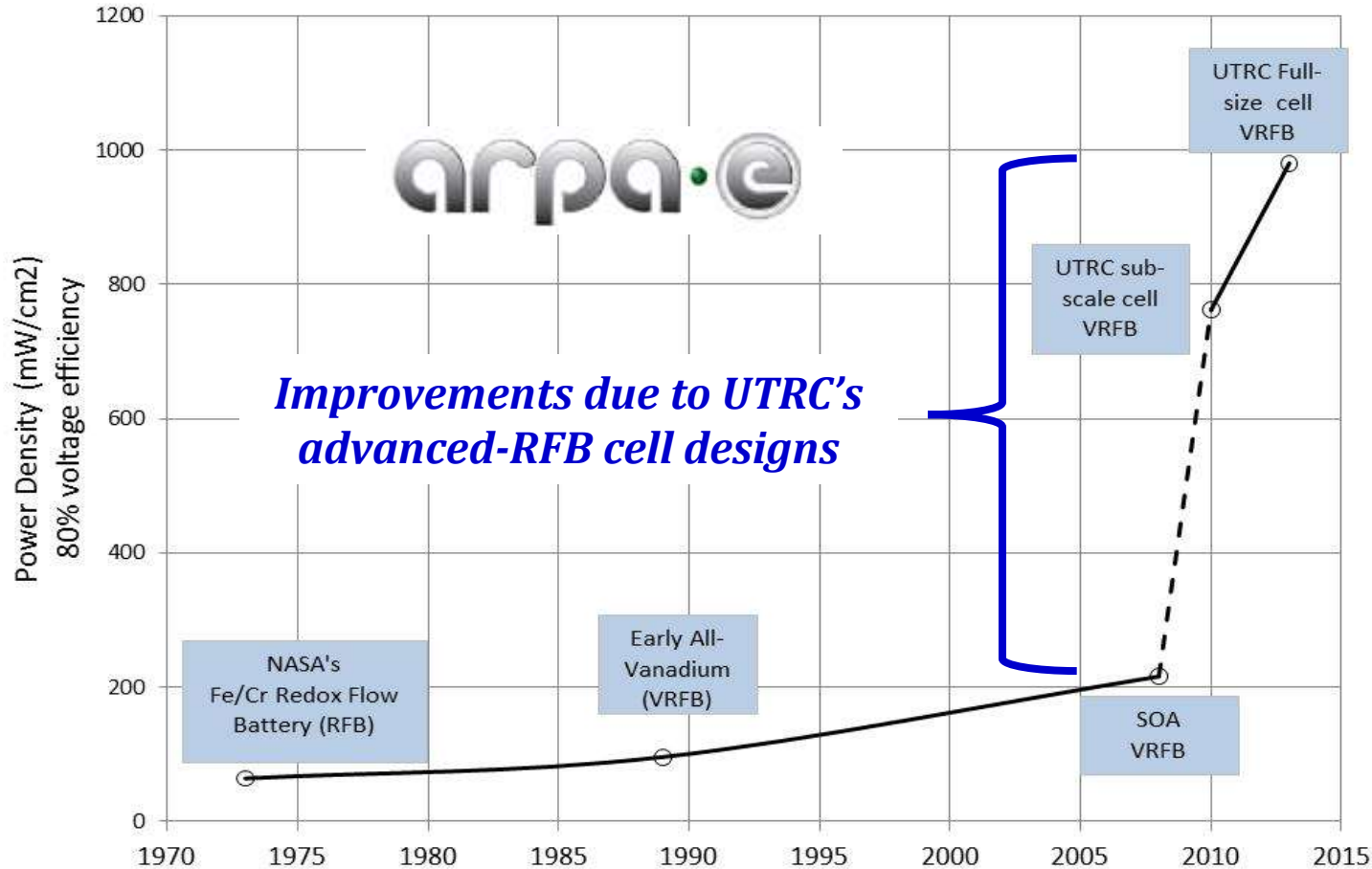
- ▶ Alkaline Sulfur/Manganese<sup>1</sup> chemistry
- ▶ Electrolyte Takeover Process (ETP)



# The Team

## “Breakthrough Flow-Battery Stack” developed by UTRC

UTRC’s VRFB cells use same material set as other VRFB cells



Commercialization by VionX Energy



# The Team

- ▶ UTRC: flow battery design, performance, modelling, and commercialization



- ▶ Hickner Group (PSU): polymer membrane synthesis & characterization











- ▶ Brushett Group (MIT): flow battery design, performance, and modelling



- ▶ Weber Group (LBNL): flow battery modeling & membrane characterization

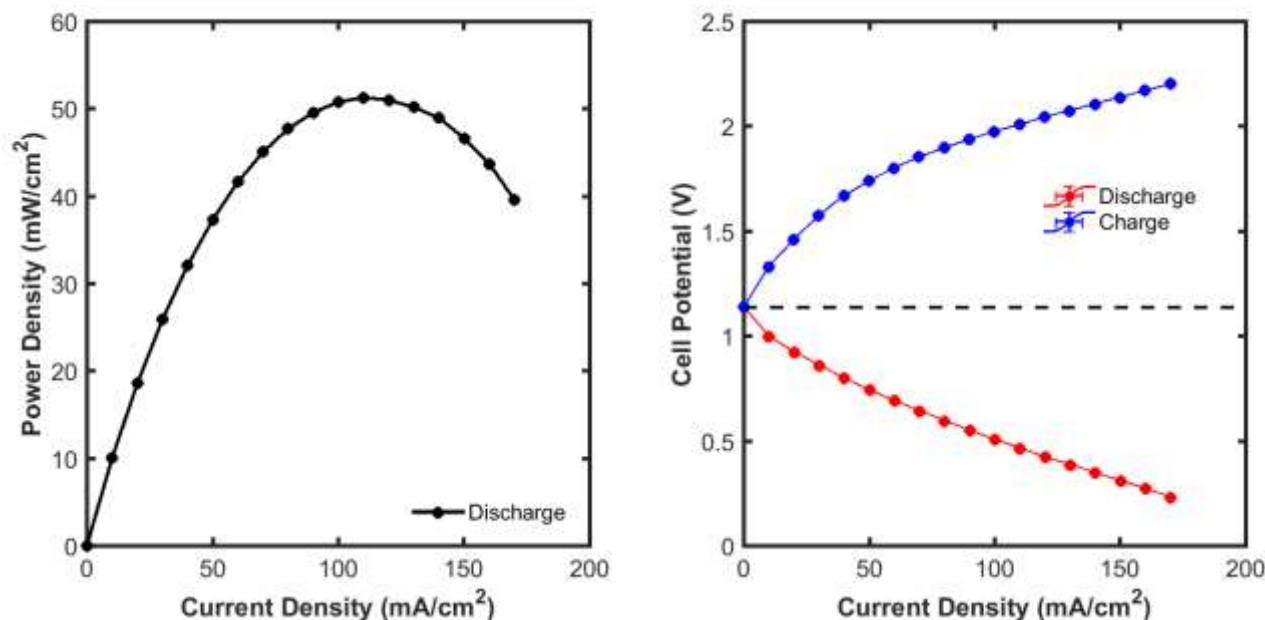


# Project Objectives

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12+	
<div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div>												6 kW / 60 kWh prototype if milestones met and further funding available
Project Management, including Tech-to-Market (T2M) Mike Perry and Dr. James Saraidaridis , UTRC								 United Technologies Research Center				
Development of high performance electrolytes, electrodes, and flow fields Prof. Fikile Brushett , MIT												
Development of advanced cation-exchange membranes (CEMs) Prof. Mike Hickner , PSU												
Development of sub-scale cells, SOC measurements, electrolyte takeover process Dr. James Saraidaridis, Dr. Zhiwei (JV) Yang , UTRC								 United Technologies Research Center				
Modeling of complete system & techno-economic analysis Dr. Rob Darling and Dr. Adam Weber , UTRC and LBNL								 United Technologies Research Center 				
Characterization of advanced RFB membranes Prof. Mike Hickner and Dr. Ahmet Kusoglu , PSU and LBNL								 				

Q#	Power Density (mW/cm <sup>2</sup> )	EE (%)	Energy Density (Wh/L)	ASR (Ω-cm <sup>2</sup> )	Capacity Loss (%/cycle)	Cycles (#)	Cycle Duration (hours)	ETP Frequency (Cycles/ETP)
Q4	25	80	≥ 30	< 3.0	< 0.4	25	5	NA
Q8	75	80	≥ 40	< 1.0	< 0.1	200	5	5
Q11	100	80	≥ 40	< 1.0	< 0.01	500/20	5/20	10

# Challenges and Potential Partnerships



## Challenges:

- ▶ System performance
- ▶ System stability at extreme *pHs*
  - Demonstrated for inorganic systems: AVRFBs are  $\text{pH} < 1$ , S/Mn likely  $\text{pH} > 14$

## Potential Partnership Areas:

- ▶ Non-fluorinated wetted materials for oxidative alkaline conditions
- ▶ Metallic flow battery electrodes
- ▶ Polysulfide catalysts